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Respirator.

(57)

A face mask (2) for a respirator is equipped with multiple seals (12, 18) on a lip (10) which turns inward at the periphery of the face mask (2). The seals (12, 18) include at least one fin which extends from the surface of the lip for contact with the face.

The respirator has a port (6) for exhalation valve near the nose of the wearer and has pleats (4) for expansion of the mask (2) between the exhalation port (6) and the chin. Inhalation ports (8) are located at the sides of the respirator near the cheeks.

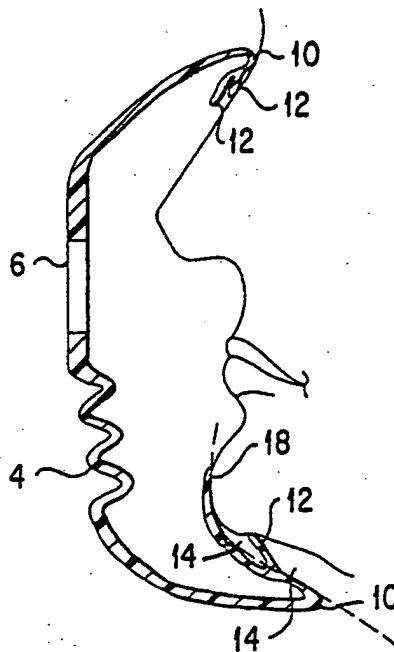


FIG. 4

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## RESPIRATOR

### FIELD OF THE INVENTION

The present invention relates to the air filtration or purification art, more specifically to a device worn over the face for air filtration, and specifically to an air filtering device which increases wearer comfort while increasing respirator performance.

### BACKGROUND OF THE INVENTION

Work is continuously being done to provide maximum protection in the area of air filtering while minimizing discomfort to the wearer of a mask designed for air filtering and purification.

The type of respirator to which the present invention is related is the respirator which utilizes a half-mask or full face mask which covers the nose and mouth and/or the entire face.

In attempting to increase protection afforded through the use of a mask-type respirator a two-point seal has previously been disclosed. Matheson, et al., U.S. Patent No. 4,414,973, teaches the use of a stiffening outer flange, or lip seal comprising a blunt edge and internal to that a curved seal to more easily conform to a wearer's face. Likewise, Lehmborg, U.S. Patent No. 2,166,164, teaches the use of an internal and external seal but only in the cheek area. The Lehmborg respirator double seal is very similar to Matheson, et al. in that it comprised a blunt outer and a curved inner seal.

The present invention increases the integrity of the seal through the employment of multiple flexible contact surfaces between the mask and the face. Two or more contact surfaces are used, the one most external being a flexible intumed lip and the remaining one or more being flexible and feathered inward toward the face creating multiple pressure pockets.

The further addition of horizontal pleats in a horizontally elongated frontal portion of the mask allows greater jaw and mouth movement for ease of talking with less shifting of the seal, thereby maximizing protection by the mask against the intrusion of unfiltered air. Although Fink, U.S. Patent No. 2,376,871, teaches the use of corrugations or ribs to permit jaw movement, these extend from the jaw hinge points on one side of the face to the other. The present invention uses pleats only on the front of the mask with a wrap around design of the mask, covering the jaw area. Location of these pleats provide a comfortable fit to wearers of varied sizes.

Increased comfort is also provided by use of this invention through the location of the inhalation and exhalation ports on the mask releasing expelled air directly and allowing fresh air to enter laterally and bathe over the face, keeping the enclosed portions of the wearer's face cool.

It is a primary object of the present invention to provide an orinasal respirator with an improved seal to exclude air from passing between portions of the mask and the face of the wearer even during movement, thereby lowering physical restrictions generally created by use of a respirator.

It is a further object of the present invention to provide for vertical expansion and contraction of the mask during movement of the mouth to decrease seal shifting thereby creating a seal with added integrity.

It is another object of the present invention to increase wearer comfort by facilitating the immediate release of hot, moist expelled gases through the location of an exhalation port or ports in the direct line of expelled breath and locating the inhalation ports on the outer sides of the mask so as to allow fresh, cool air to circulate over the wearer's face.

### SUMMARY OF THE INVENTION

The foregoing objects and other objects inherent from the following disclosure are accomplished by the present invention and method for use thereof.

The invention in its broadest aspect comprises a device for filtering or purifying air to be worn over the face, and especially over the mouth and nose, which maintains a secure seal of the mask to the face even during movement and talking, while increasing wearer comfort.

The increased seal integrity of the respirator described herein is maintained through the use of multiple contact points, or intermediate seals, which create independent pressure pockets or areas between the seals. These intermediate contact surfaces are flexible to maintain contour to the face even during slight shifting, and pointed inward on the face to increase contact ability during movement of the mask, thereby further limiting intrusion of air into the mask. Individual pressure pockets demonstrate the increased integrity of the seal between the atmosphere and interior of the mask where the additional contact surfaces act as multiple, individual barriers to the atmosphere. Even if there is shifting during movement, seal integrity is maintained by the flexibility of the intermediate

seals working to keep in contact with the face and multiple contact surfaces as additional lines of defense against the atmosphere. These improvements lower physical restrictions on the wearer during use of the respirator.

Means are included for allowing vertical expansion and contraction of the mask in the front lower portion of the mask combined with a horizontally elongated mask structure for maintaining the integrity of the seal and providing wearer comfort during movement of the jaw and mouth during talking. This means permits the wearer to talk more freely by allowing vertical mouth movement under the mask without substantial shifting of the mask on the face, shifting causing the likelihood of air entering between the mask and the face. Also, a wider range of face sizes can be fitted by the use of these means.

The mask described herein further increases wearer comfort through the location of the inhalation and exhalation ports. One or more one-way exhalation valve ports are located in a direct line with expelled air, i.e., directly in front of the mouth and nose. This placement allows expelled air to exit the mask easily and not be withheld in the interior of the mask. This is important because expelled air is hot and contains moisture which will make the wearer's skin under the mask uncomfortable during periods of extended wear. Wearer comfort is further enhanced by lateral placement of one or more inhalation ports to the outside of the mask over the cheek area. Lateral placement of the inhalation ports allows the fresh air to be taken in over the face, thereby keeping the skin under the mask cool and comfortable.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a front elevational view of a respirator mask in accordance with the invention.

FIGURE 1A is a cross-sectional view of the mask edge through line 2-2 of FIGURE 1.

FIGURE 1B is a cross-sectional view of the mask edge through line 3-3 of FIGURE 1.

FIGURE 1C is a cross-sectional view of the mask edge through line 4-4 of FIGURE 1.

FIGURE 1D is a cross-sectional view of the mask edge through line 5-5 of FIGURE 1.

FIGURE 2 is a side elevational view of the respirator.

FIGURE 2A is a cross-sectional view of the respirator through line 1-1 of FIGURE 1.

FIGURE 3 is a back elevational view of the respirator.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, reference numeral 2 designates, in general, a respirator mask constructed in accordance with the teachings of the present invention. The mask 2 is formed substantially in the shape of the portion of the face which it covers from a mostly flexible material, silicone rubber being most preferred, to allow contour to the face of the wearer for an effective seal. In the preferred embodiment, a half mask is employed, covering the nose and mouth of the worker, starting at the bridge of the nose, running across the cheeks and along the bottom of the chin, forming an airtight seal.

As seen in FIGURES 1A-1D and 2A, the mask edge 10 comprises form fitting portions which help provide an air tight seal further comprising additional interior projections, or intermediate seals 12, and an inner seal 18 pointing inward along the face. The mask edge 10 is of the turnover type, having an intumed lip as the outer contact surface of the mask 2 to the wearer's face. This turnover edge 10 extends on the face and ends providing another contact point, most internal within the mask 2, known as the primary inner seal 18. The intermediate seal or seals 12 are located between the mask edge 10 and the primary inner seal 18. The number of intermediate contact surfaces 12 can be varied, the preferred embodiment containing one (1) intermediate seal 12 between the mask edge 10 and the inner contact surface 18 (see FIGURES 1A-1D). The intermediate seal 12 are feathered and flexible to allow them to maintain their position on the face even when the respirator 2 shifts slightly. The mask 2 makes contact with the wearer's face at the mask edge 10, at each of the intermediate seals 12, and creating individual pressure pockets 14 between the primary inner seal 18 at the contact points (see FIGURE 2A). Flexibility of the intermediate seals 12 provide contact surfaces which hold the face contour even during shifting. To accomplish this the length of the extension comprising the intermediate seal 12 varies along the perimeter of the mask 2, being the shortest at the bridge of the nose and the longest in the chin area. The pressure pockets 14, created between the contact surfaces and the face, provided increased seal integrity with additional barriers between the environment and the internal mask area. These additional flexible barriers 12 maintain a superior seal thereby lowering physical restrictions and allowing freer movement by the wearer without leakage of air into the mask 2 from the mask edge 10 at face contact points.

Pleats 4 on an elongated mask front are the preferred structure for providing a means to allow vertical expansion and contraction of a portion of the mask 2 relating to jaw movement and movement of the mouth for talking (see FIGURES 1 and 2). In the preferred embodiment the pleats 4 comprises an area 4 inches wide and 1 3/4 inches high on the front of the mask 2. The number of pleats 4 is not of great importance as long as they are sufficient in number and size to allow accordion type vertical expansion and contraction of between 3/4 and 1 3/4 inches. The bigger the pleats 4 the fewer will be necessary to provide said vertical lift, likewise, a greater number of smaller pleats 4 will be necessary to achieve the same vertical lift.

For example, three (3) pleats 4 comprising five (5) folds of 1/2 inch between folds provides the desired vertical lift for normal use. Elongation of the mask width further provides freer jaw movement and the combination of pleats 4 and elongation provide a better fit for a greater variety of facial sizes.

A key feature of the preferred embodiment is to provide width sufficient to wrap around the user's face extending almost to the sideburn area. In contrast to the prior art, this provides for the greatest freedom of jaw movement without risk of breaking the seal, and it permits use with lower headband tension and allows for longer periods of comfortable wear. Prior art devices which do not have sufficient wrap around rest on the cheekbones, and distort the skin and can be exceedingly uncomfortable after relatively short periods of wear.

In general, the ratio of the maximum distance measured horizontally from edge to edge to the maximum distance measured vertically from edge to edge will be in excess of 1.0:1 and preferably in excess of 1.5 to 1 and most preferably in excess of about 2.0 to 1. In any event, the ratio should not exceed 3.0 to 1, which puts the edges into the sideburns and also can fail to adequately cover the entire nose and chin. Usually, the prior art employs ratios of less than 1.0 to 1 which has the drawback of lack of comfort.

Provision of a seal having multiple, flexible intermediate contact points 12 which more readily retain their original placement on the face, including a structural means for allowing vertical expansion during mouth movement and a wrap around design extending the mask 2 farther back on the sides of the face maximizes worker protection from unfiltered air thereby increasing user comfort.

The wearer's comfort is further increased through use of the present invention due to placement of the exhalation 6 and inhalation 8 ports (see FIGURES 1, 2 and 3). A one-way exhaust port 6 is placed on the front, middle portion of the mask 2 in a direct line with the expelled breath of the wearer

(see FIGURE 2A). Since expelled breath is hot, moist air, it is uncomfortable for the wearer to allow it to build up inside the mask 2. The one-way exhalation port 6 placed in the direct line of expelled breath allows easy exit of the hot, moist air without substantial retention within the mask 2. Lateral placement of the inhalation ports 8 toward the outside portions of the mask 2 is provided to allow cool, fresh air to be drawn in over the portion of the face enclosed by the mask 2 thereby bathing the enclosed face in the cool, fresh air and increasing comfort of the wearer by limiting build-up of stagnant, hot and humid air.

The inhalation ports 8 comprise cannister filtering devices such as chemical cartridges, high efficiency filters, or other known in the art located 2 3/4 inches from the side ends of the mask and are attached to the inhalation valves. The inhalation valves are in only check valves of the flapper variety being approximately 1 3/8 inches in diameter. The inhalation valves can also be attached to a self-contained air supply if filtering is sufficient in the designated atmospheric conditions.

In preferred embodiments, the exhalation valve is an out only check valve of the mushroom flapper type being approximately 1 1/2 inches in diameter.

The mask 2 is maintained firmly on the wearer's face by a suitable device known in the art designed to maintain a constant pressure of the mask 2 on the wearer's face. The preferred maintenance device comprises a yoke which fits over the front of the mask 2, with openings over the inhalation and exhalation valve areas, which does not interfere with the vertical expansion and contraction feature of the pleats 4, also on the front of the mask 2. The yoke has attachment points on the corners to attach head bands adapted to conform to the wearers head.

## Claims

1. A respirator mask for filtering or purifying air adapted to be worn over the face which comprises a means for increasing seal integrity comprising at least two contact surfaces internal to the turnover seal edge making contact with the face, the most interior of which is a primary inner seal and at least one other interior contact surface between the primary inner seal and turnover edge seal which is also flexible to maintain its position during slight shifting during movement, on the sealing perimeter of the mask making contact with the face and providing multiple pressure pockets or areas between said contact surfaces thereby creating a seal with less chance of leaks to the outer atmosphere.

2. A respirator mask as in Claim 1 further comprising:

(i) a means for providing vertical expansion and contraction of the mask to facilitate talking without substantial movement of the turnover seal edge;

(ii) one or more exhalation valves in the direct line of expelled breath to allow said expelled breath to exit the mask directly; and

(iii) two or more inhalation valves on either side of said mask to allow fresh air to move over the face.

3. A mask as in Claim 2 wherein the means for improving seal integrity comprising the contact surfaces internal to the mask edge comprise feathered, flexible extensions which provide separate pressure pockets between contact points increasing the number of barriers to the atmosphere.

4. A mask as in Claim 3 wherein the flexible extensions internal to the mask edge are thinner at the ends and angled inward to the face to maintain contact with the face during shifting.

5. A mask as in Claim 4 wherein the means for providing vertical expansion and contraction comprises a plurality of horizontal pleats across the front lower portion.

6. A mask as in Claim 5 wherein the inhalation and exhalation ports are one way valves located such that the exhalation port or ports are in a direct line with the expelled breath, promoting easy exit of expelled breath, and inhalation ports are one way valves located laterally over the cheek areas to provide fresh, cool air to flow over the covered portion of the face.

7. A mask as in Claim 6 wherein the flexible extensions extend varied lengths around the perimeter of the mask, being shortest at the nose area and longest at the chin area, at an angle inward to the face.

8. A mask as in Claim 7 wherein the horizontal pleating is about 4 inches wide and about 1 3/8 inches high on the front lower portions of said mask allowing vertical expansion and contraction of between 3/4 and 1 3/4 inches.

9. A mask as in Claim 8 wherein the exhalation valve is an out only check valve of the flapper type being 1.45 ± 0.1 inches in diameter.

10. A mask as in Claim 9 wherein the inhalation valves are in only check valves of the flapper type capable of attachment to cannister filters located 2 3/4 inches from the side ends of the mask and are 1.35 ± 0.1 inches in diameter.

11. A mask as in Claim 10 comprising one intermediate contact surface between the outer contact surface and the primary inner contact surface.

12. A mask as in Claim 11 adapted to be held in place by head bands attached to a yoke fitting over the front of said mask without limiting expansion and contraction by the pleats.

13. A mask as defined in Claim 2 wherein the ratio of the maximum length measured horizontally from edge to edge to the maximum length measured vertically edge to edge is greater than about 1.0:1.

14. A mask as in Claim 13 wherein the ratio of the maximum length measured horizontally from edge to edge to the maximum length measured vertically from edge to edge is in excess of about 2.0:1.

15. A mask as in Claim 14 formed from materials characteristically similar to materials from the group consisting essentially of silicone rubber, natural rubber, polyvinyl chloride, and neoprene rubber.

16. A mask as in Claim 15 formed from silicone rubber.

Neu eingereicht / newly filed  
Nouvellement déposé

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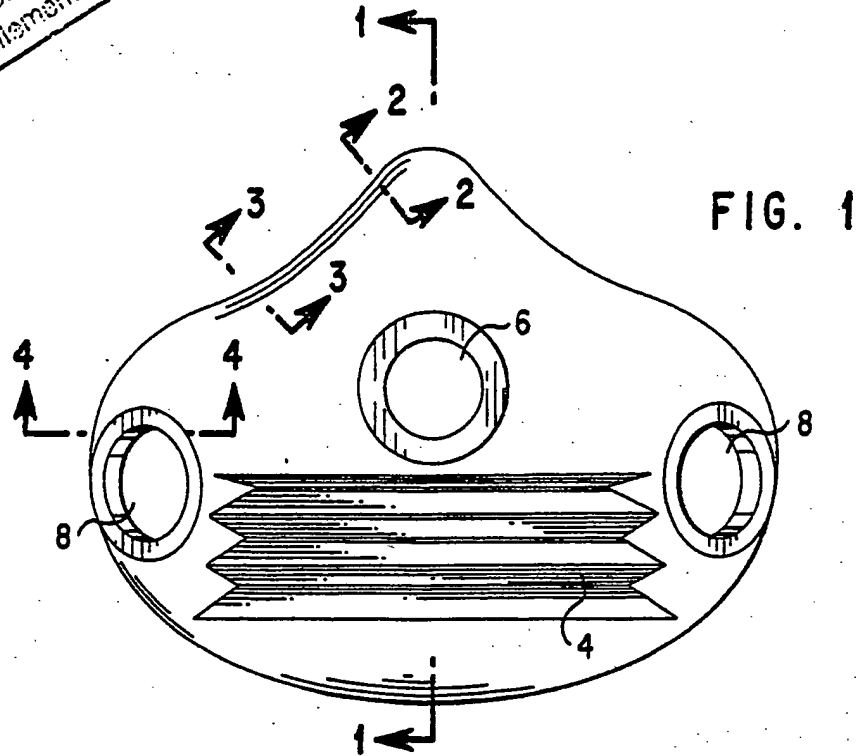


FIG. 1

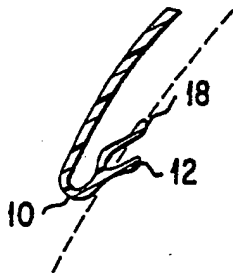


FIG. 1A

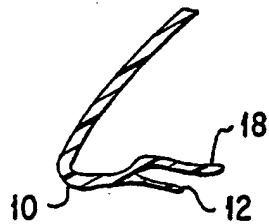


FIG. 1B

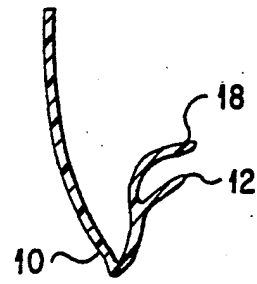


FIG. 1C

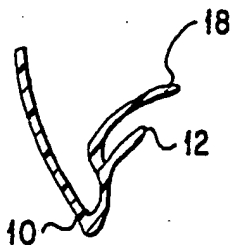


FIG. 1D

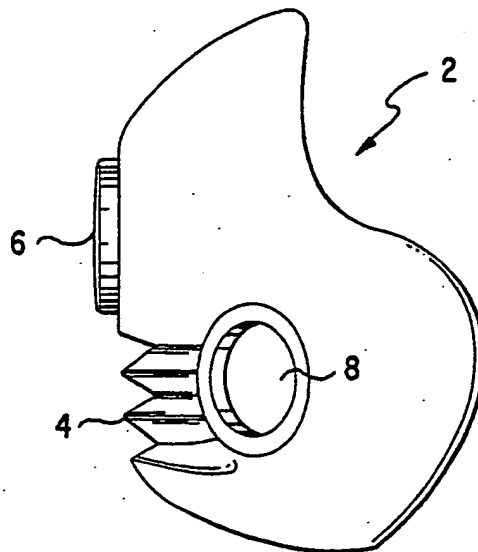


FIG. 2

Neu eingereicht / Newly filed  
Nouvellement déposé

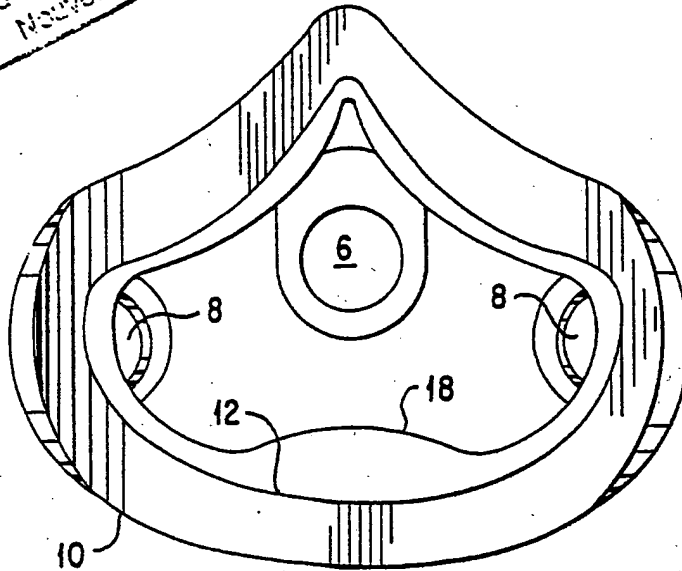


FIG. 3

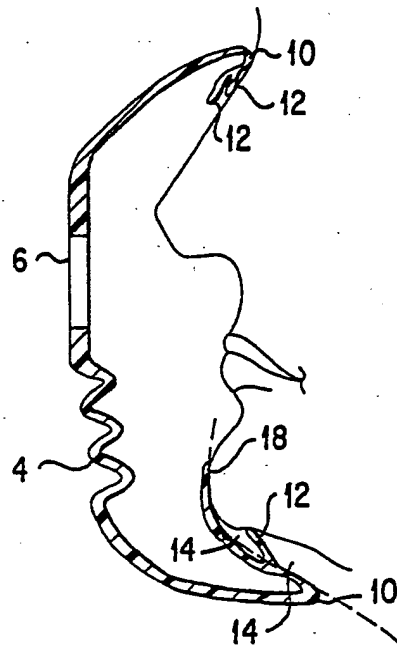


FIG. 4



European Patent  
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# EUROPEAN SEARCH REPORT

Application Number

EP 87 11 4903

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	US-A-3 343 535 (J.P. LYTLE et al.) * Column 1, line 57 - column 2, line 17; figure 1 * ---	1-4,6, 11,15	A 62 B 18/02
Y	US-A-2 706 983 (MATHESON et al.) * Column 1, line 71 - column 2, line 57; figures 1-3 * ---	1-4,6, 11,15	
X	GB-A-2 173 109 (DRAGERWERK AG) * Page 2, lines 18-58; figure 1 * ---	1,3,4	
A	US-A-2 376 871 (FINK) * Page 1, right-hand column, lines 19-27; figures 1-3 * ---	5,13	
A	DE-B-1 142 500 (DRÄGERWERK, HEINR. & BERNH. DRÄGER) * Column 2, lines 20-28; figure 1 * -----	5	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			A 62 B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19-01-1988	Examiner WOHLRAPP R.G.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons ----- & : member of the same patent family, corresponding document			

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